NASA/CR-97- 206119

IN 05-CR
OCIT
078123

Title: Advanced Design Methodology for Robust Aircraft Sizing and Synthesis
Report: Performance Report
Period: January 22, 1997 - November 21, 1997

Submitted to:

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NAG-1-1793

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November 11, 1997

SUMMARY OF CONTRACT PERIOD EFFORTS

Contract efforts are focused on refining the Robust Design Methodology for Conceptual Aircraft Design. Robust Design Simulation (RDS) was developed earlier as a potential solution to the need to do rapid trade-offs while accounting for risk, conflict, and uncertainty. The core of the simulation revolved around Response Surface Equations as approximations of bounded design spaces.

An ongoing investigation is concerned with the advantages of using Neural Networks in conceptual design. In the overall design methodology, one possibility for the application of Neural Networks is as an alternative to the Response Surface Equations, which are limited in both the number of parameters and their ranges. To investigate this, a first step was to implement a two-layer (one hidden layer) feed-forward neural network with pure linear and tangent sigmoidal transfer functions to approximate the design metrics of various disciplines and bring them back to the systems level. Some aspects in this approach were found to need special attention. Among them are the selection of the number of neurons in the hidden layer, which were adjusted with the learning behavior, and the appropriate training methods for the neural network. The network was trained via backpropagation methods, and the development of suitable training methods will lead to genetic algorithms and other methods to be used for this purpose.

Thought was also given to the development of a systematic way to choose or create a baseline configuration based on specific mission requirements. To explore the possibilities of Knowledge-Based Systems with their reasoning and database mining capabilities, an Expert System was developed, which selects aerodynamics, performance and weights models from several configurations based on the user's mission requirements for subsonic civil transports. This motivates future research toward investigating a hybrid system of artificial intelligence methods, possibly Neural Networks combined with Knowledge-Based Systems, to systematically select or develop baseline configurations for unconventional aircraft designs. In addition, such a hybrid system can potentially provide design guidance in the larger scope of the overall RDS.

The investigation of affordability in the design process has made the investigation of a probabilistic approach to design necessary, due to the inherent ambiguity of assumptions and requirements as well as the uncertain operating environment of future aircraft. The approach previously developed at ASDL, linking Response Surface Methodology with Monte Carlo Simulations, has revealed itself to be cumbersome and at times impractical for multi-constraint, multi-objective problems. In addition, prediction accuracy problems were observed for certain scenarios that could not easily be resolved. Hence, a portion of this year's research focused on an alternate approach to probabilistic design, which is based on a Fast Probability Integration (FPI) technique. Critical reviews of the combined Response Surface Equation/ Monte Carlo Simulation methodology against the Advanced Mean Value (AMV) method, one of several FPI techniques, has been accomplished. Both methods are used to generate cumulative distribution functions, which are subsequently compared in an example case studies, usually employing a High Speed Civil Transport (HSCT) concept. Outcomes of this research and the case studies have been an assessment and comparison of the analysis effort and time necessary for both methods is performed. In summarizing the results, the Advanced Mean Value method shows significant time savings over the Response Surface Equation/Monte Carlo Simulation method, and generally yields more accurate CDF distributions. The research has also resulted in a step-by-step illustration on how to use the AMV method for distribution generation and the search for robust design solutions to multivariate constrained problems.